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Bloxsom et al.

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(54) **LEADER STRING PULL-THROUGH MACHINE**

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B61B 13/10 (2006.01)

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(58) **Field of Classification Search** 180/9.1, 180/9.5; 104/138.1, 138.2
See application file for complete search history.

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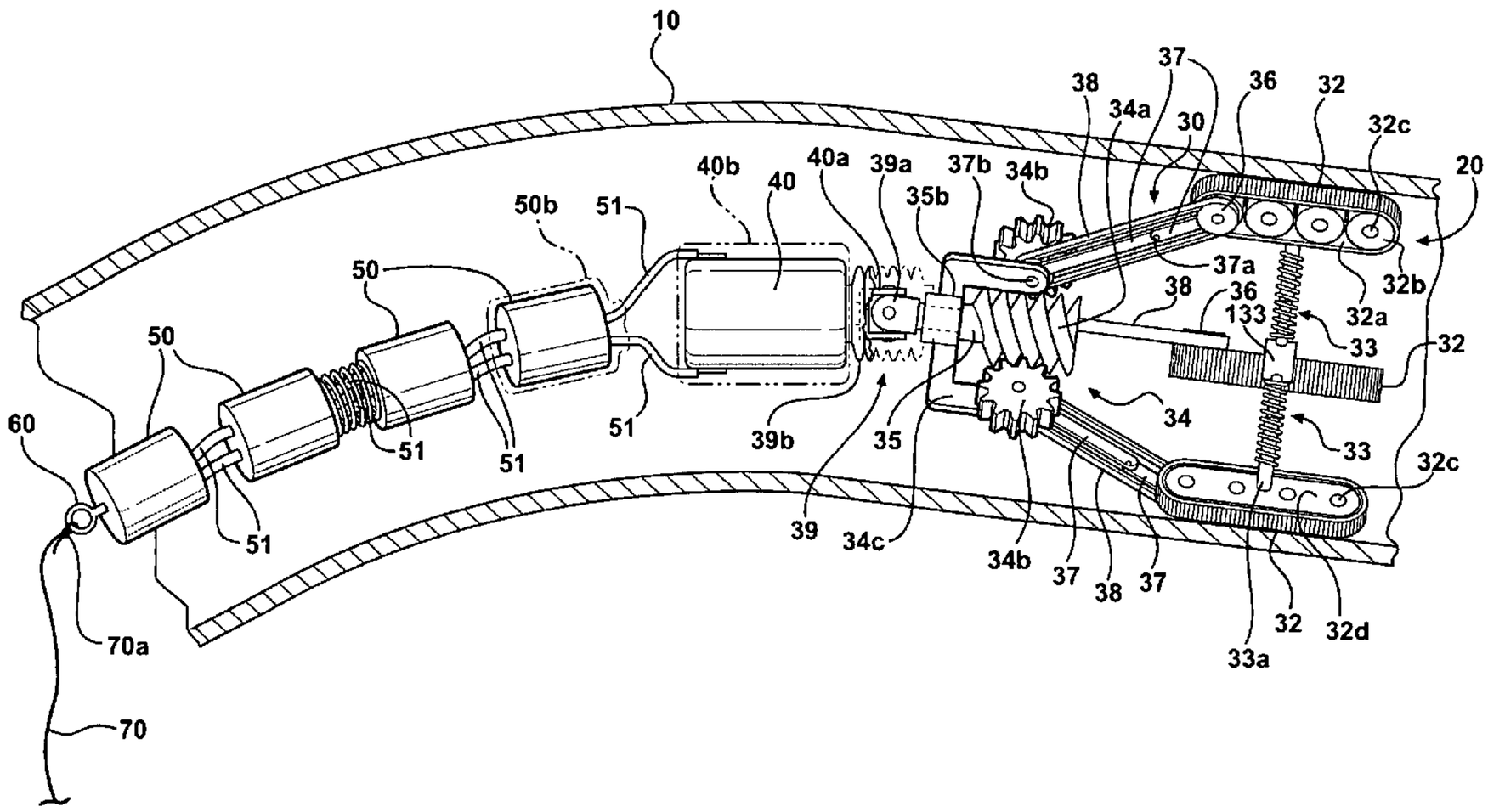
(57) **ABSTRACT**

A crawler device for pulling a leader string through electrical or cable conduit. The crawler device has a traction head, for example using caterpillar-type rubber tracks, biased outwardly into contact with the inner wall of the conduit when inserted in the conduit. The traction head pulls its own motor and power supply behind it, serially and flexibly linked to follow the traction head and negotiate curves in the typically small diameter electrical conduit. In the preferred from, the power supply is a series of linked batteries, such that the crawler is an independently and self-sufficiently mobile machine traveling through the conduit.

11 Claims, 5 Drawing Sheets



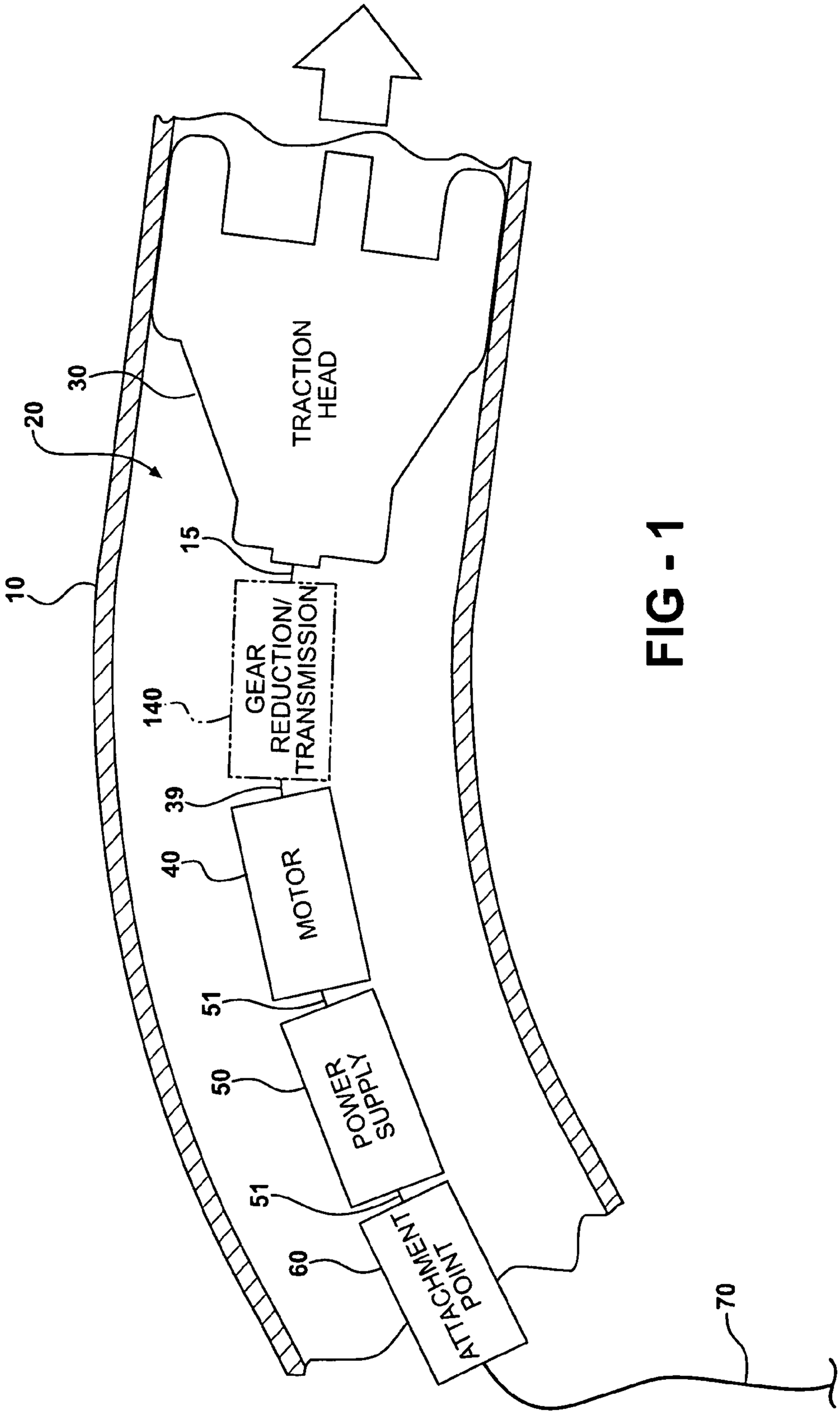
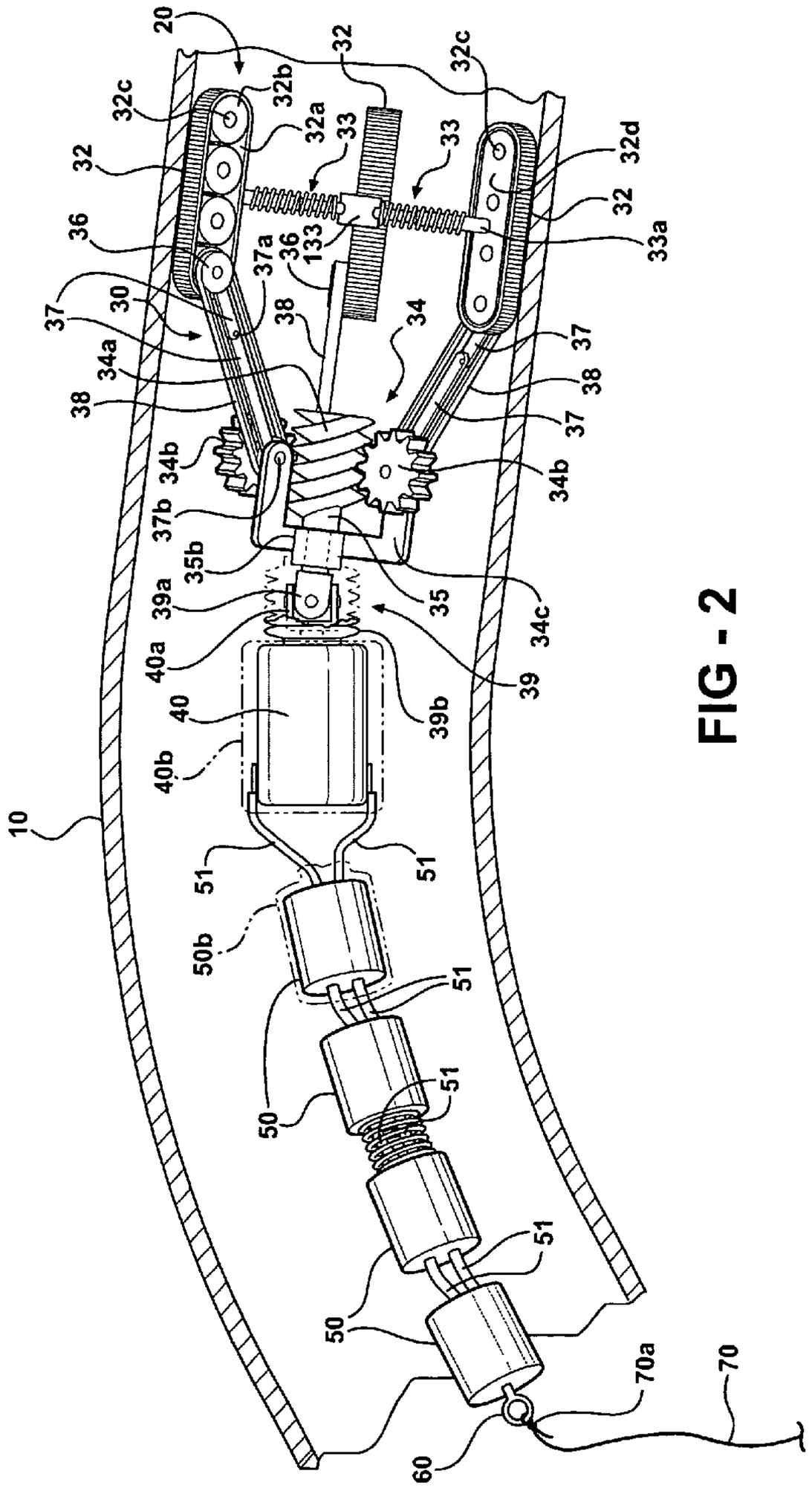

TRACTION HEAD
GEAR REDUCTION/ TRANSMISSION
MOTOR
POWER SUPPLY
ATTACHMENT POINT
10
15
20
30
39
40
50
51
51
60
70
140

FIG - 1


20
32
32c
32b
32a
33
33
32c
32d
32
32
36
37a
36
133
33a
37
30
38
34
34a
38
37
38
37
34b
34b
37b
35b
39a
35
34c
40a
39
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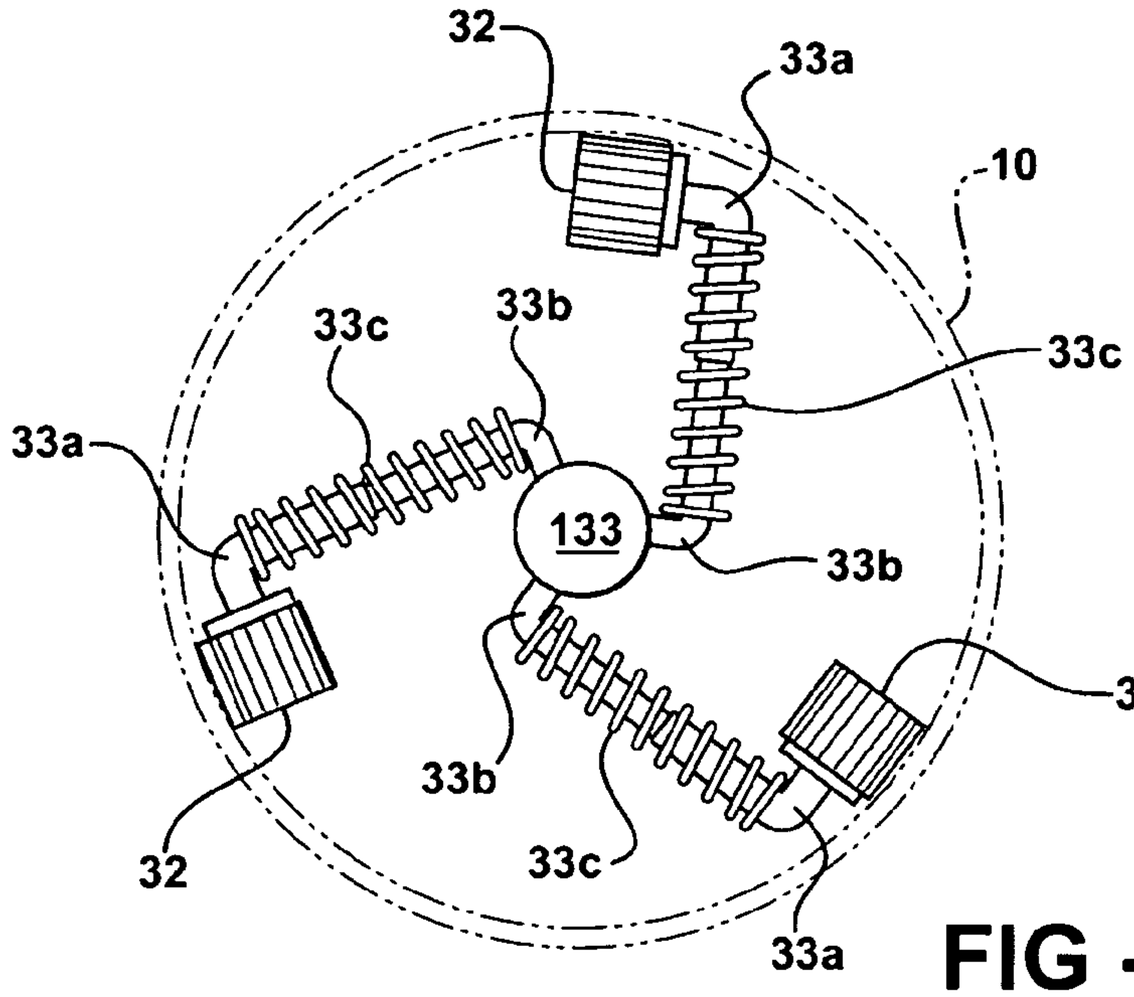
51
50
51
51
50
70a
70
60

FIG - 2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33a
10
33c
33b
33c
33a
133
33b
32
33b
33c
32
33a

FIG - 3

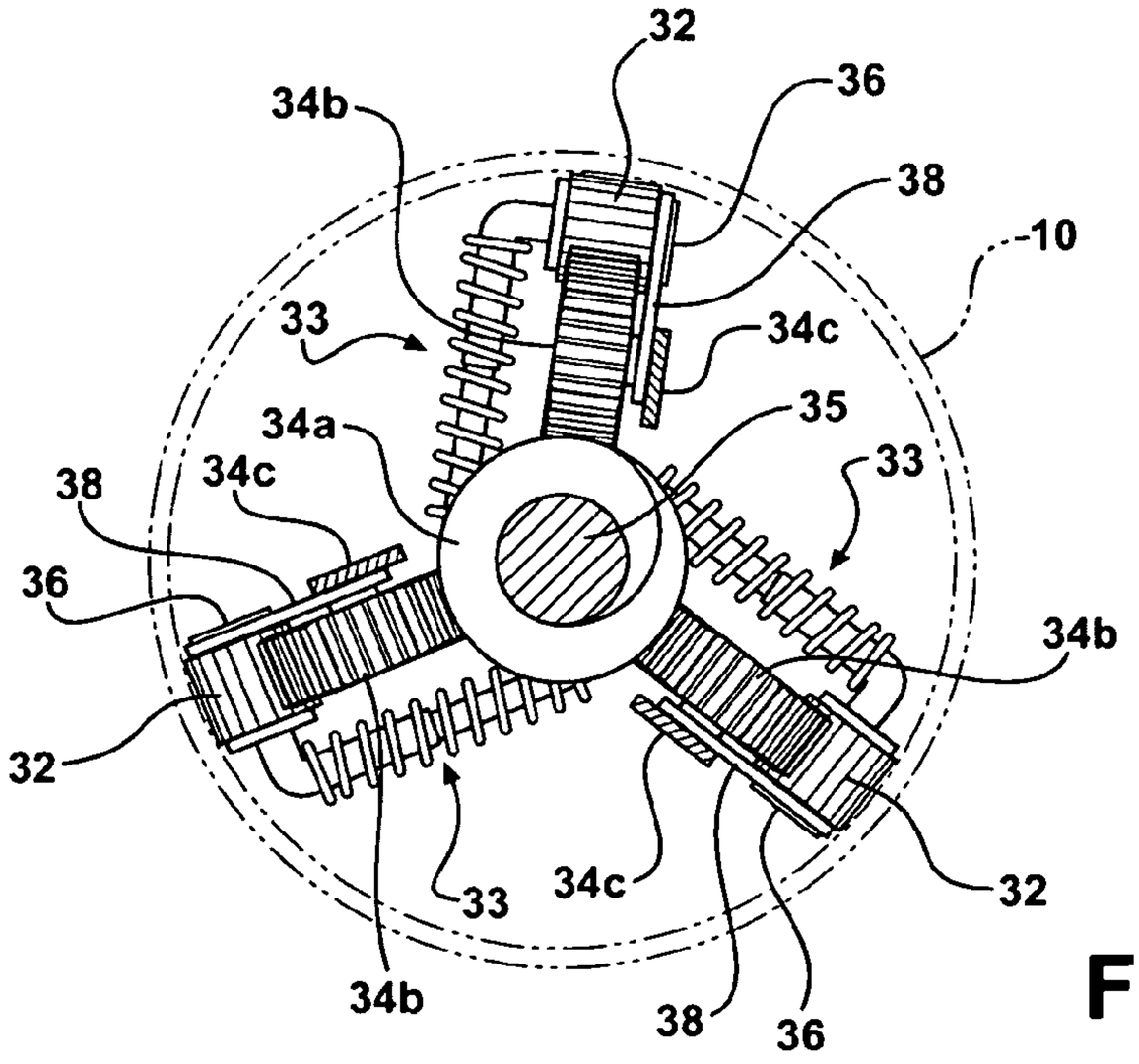
32
36
34b
38
10
33
34c
35
34a
33
38
34c
36
34b
32
34b
33
34c
32
34b
38
36

FIG - 4

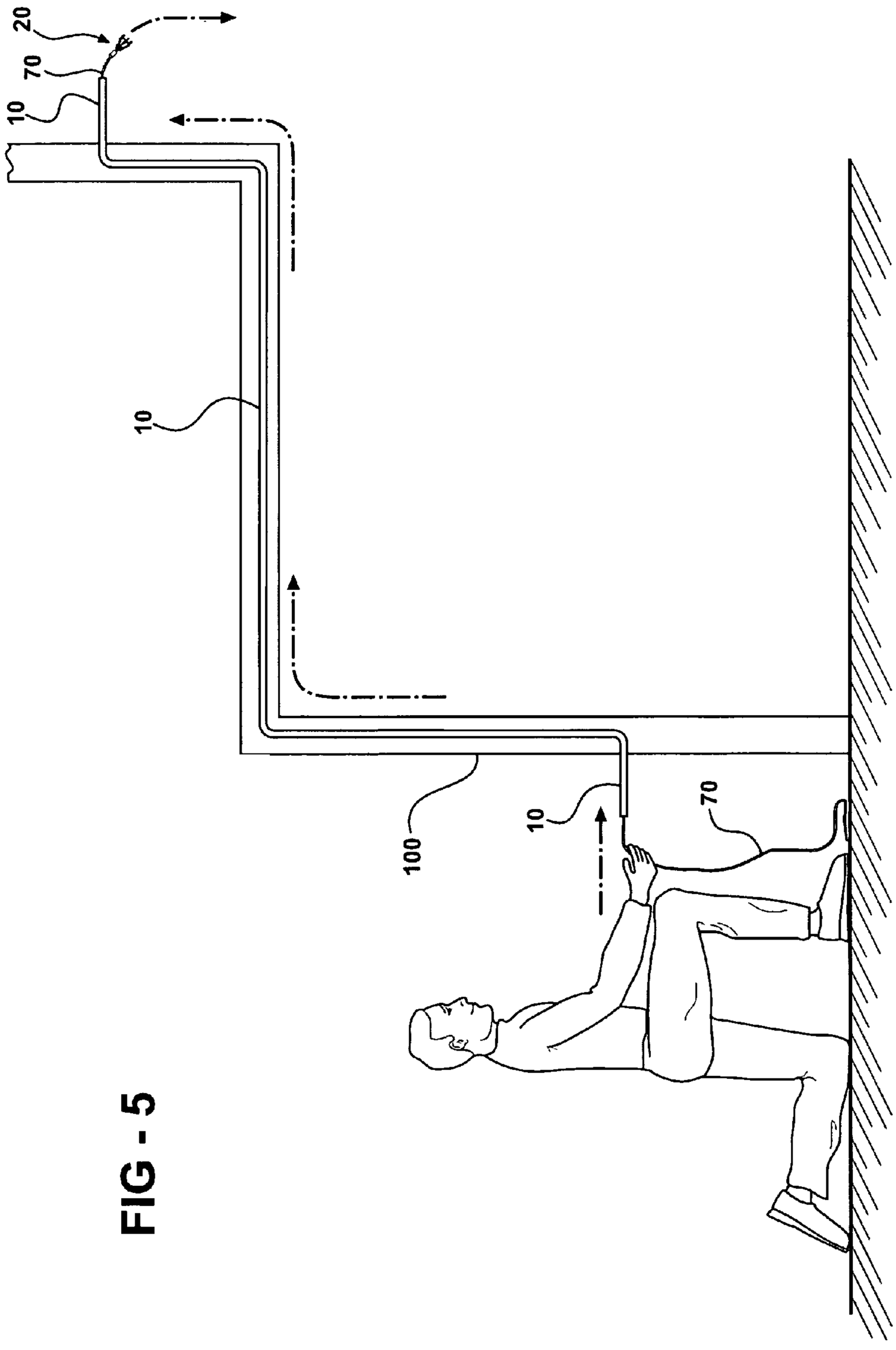

FIG - 5

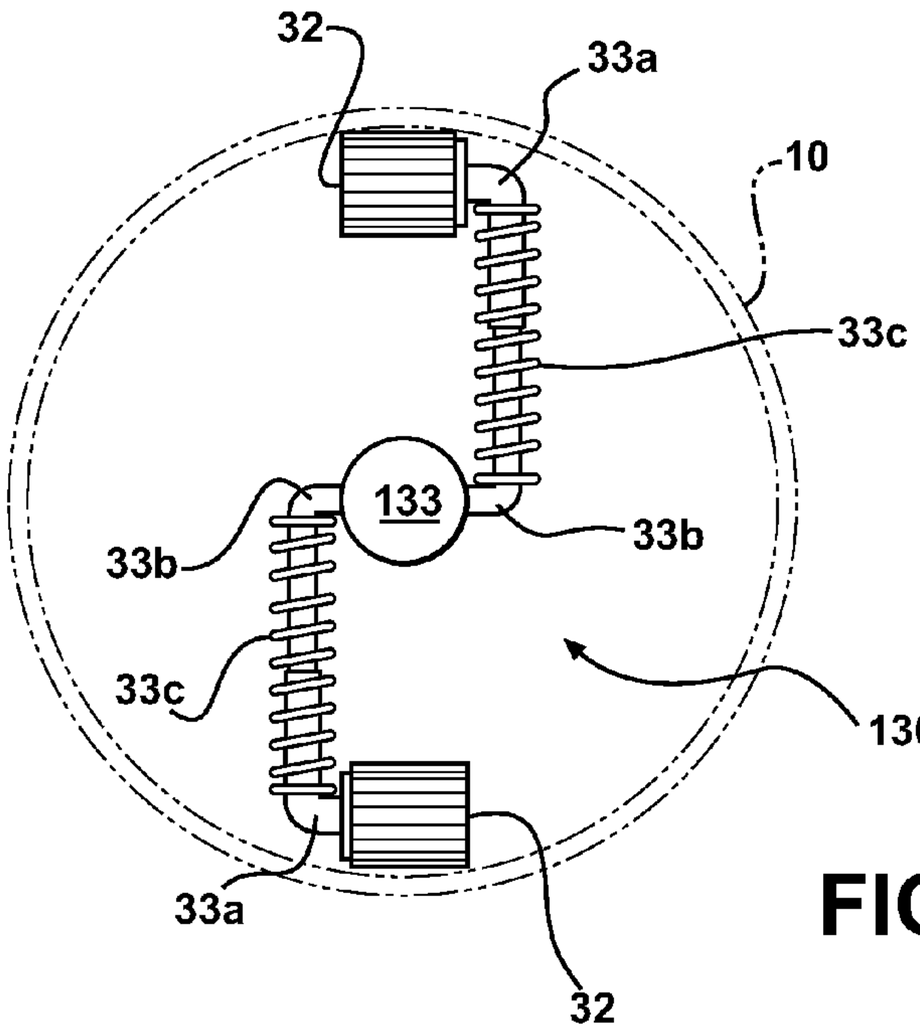
32
33a
10
33c
133
33b
33b
33c
130
33a
32

FIG - 6

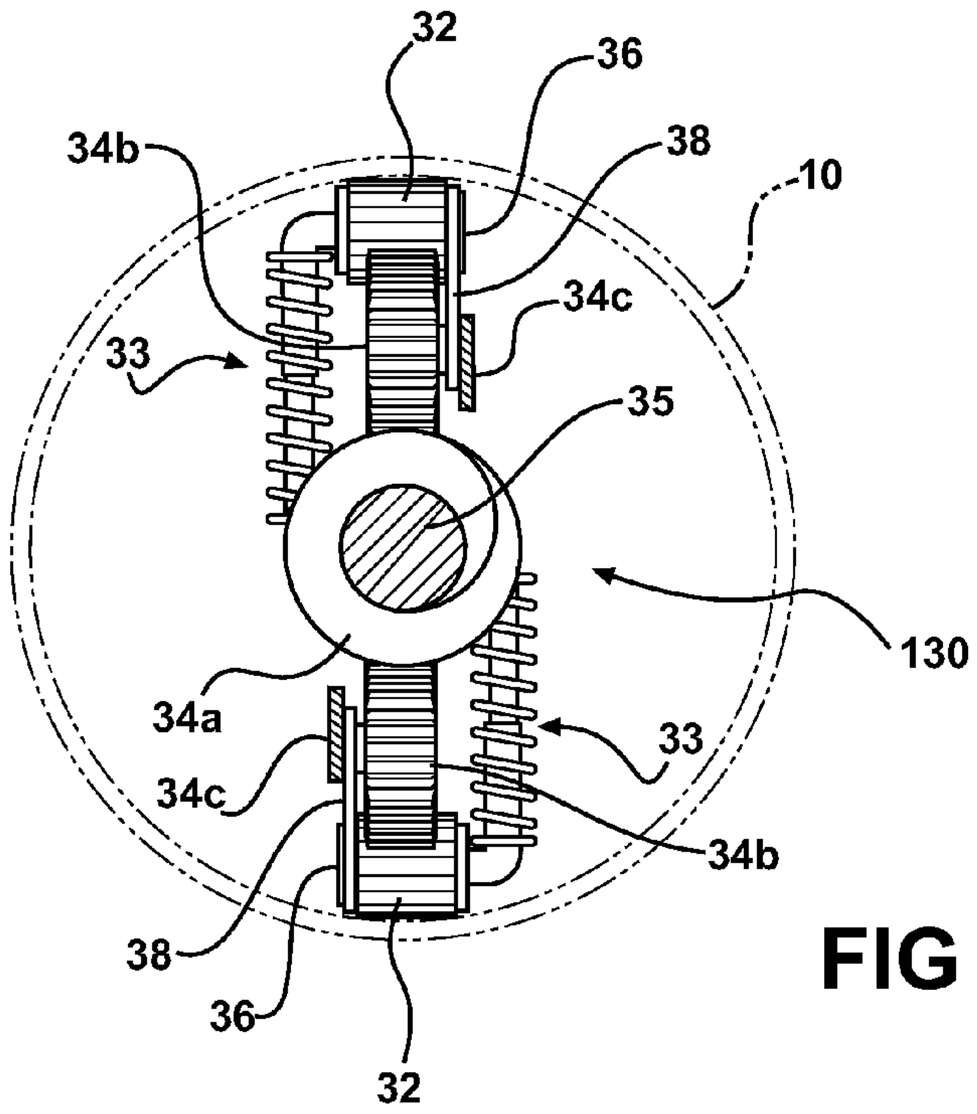
32
36
34b
38
10
34c
33
35
130
34a
33
34c
34b
38
36
32

FIG - 7

LEADER STRING PULL-THROUGH MACHINE

FIELD OF THE INVENTION

The invention is in the field of devices for pulling leader string for electrical wiring through an electrical conduit.

BACKGROUND OF THE INVENTION AND DESCRIPTION OF RELATED ART

Electricians and cable installers commonly use a device known as a "fish tape" to help install wiring or cable in an empty conduit. The fish tape is typically a stiff metal or plastic tape fed from a reel with a hand crank to push it through the empty conduit until the free end of the tape sticks out the other end of the conduit. A "leader string" (a term which includes string, cord, lightweight wire, or any other equivalent used for the same purpose) is attached to the free end of the tape, which has a built-in string attachment structure such as a hook or clip, and then the installer rewinds the tape until the leader string has been pulled back through the conduit. The exposed end of the leader string is then attached to a wire or cable, and then the other end of the leader string is used to pull the wiring or cable (hereafter "wiring") back through the conduit.

Experience shows fish tapes to be heavy, difficult to wind and unwind, slow, and tiring to use when long runs of conduit are being wired.

BRIEF SUMMARY OF THE INVENTION

According to the invention, a leader string pull-through device is provided in the form of a small powered tractor device, hereafter referred to as a "crawler", with wheels or treads held in traction against the inside wall of an electrical or cable conduit to crawl through the conduit while pulling a leader string. The crawler is small enough and flexible enough to negotiate typical conduit diameters and curves, and in the preferred form has a jointed, multi-part structure led by a rubber-treaded traction head that pulls its motor drive and power supply after it.

In a further aspect, the crawler's traction head has two or more opposed caterpillar-type tracks or wheel carriages (hereafter "tracks"), the tracks biased into constant contact with opposing sides of the conduit's inner wall for good traction. In the preferred embodiment the crawler head has three crawler tracks, "opposed" in the sense that they are equally forced apart from one another relative to a central axis to provide a balanced drive force against the inner wall of the conduit.

In a further aspect, the multi-part crawler includes separate but flexibly coupled crawler head, motor, and power supply portions. In yet a further aspect, the crawler head uses a belt-and-pulley type drive, with a worm gear operated by a single in-line motor following the crawler head. In still a further aspect, the motor is powered by one or more in-line batteries flexibly coupled to follow the motor.

The motor can be directly coupled to the crawler head drive, or can be connected to the drive through a gear reduction mechanism. Various parts of the crawler "train" can be combined, provided sufficient flexibility is maintained to negotiate curves in the conduit. For example, it might be possible to build the motor into the crawler head to directly drive the tracks.

These and other features and advantages of the invention will become apparent from the detailed description below, in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cutaway side view of a section of electrical wiring conduit, with a schematic representation of a crawler apparatus according to the invention inside the conduit.

FIG. **2** is similar to FIG. **1**, but shows a preferred, detailed embodiment of a crawler apparatus according to the invention.

FIG. **3** is a front-end view of the track portion of the crawler traction head from FIG. **2**, with the conduit wall in phantom.

FIG. **4** is a rear-end view of the crawler traction head from FIG. **2**, with the conduit wall in phantom.

FIG. **5** is a perspective view of an electrician using the crawler of FIG. **2** to pull a leader string through an electrical conduit.

FIG. **6** is similar to FIG. **3**, but shows a front-end view of a modified track portion of the crawler traction head with two tracks.

FIG. **7** is similar to FIG. **4**, but shows a rear-end view of the modified track portion of the crawler traction head from FIG. **6** with two tracks.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to FIG. **1**, the invention is illustrated schematically as crawler device **20** running inside a standard size electrical wiring conduit **10**, for example 1-inch diameter metal or plastic conduit of the type used to protect the wiring in common residential and commercial building construction, or any other similar type of electrical tubing including but not limited to flexible metallic tubing. Crawler **20** includes a traction head **30** in constant tractive engagement with the inner wall of conduit **10**. Traction head **20** is coupled to and pulls an electric motor **40** that drives traction head **20** through a flexible drive coupling **39**, and optionally also through a gear reduction transmission **140**. Motor **40** is in turn flexibly coupled to pull along a power supply **50**, which in the preferred form is one or more batteries **50** electrically and mechanically coupled to each other and to motor **40** at electromechanical couplings **51**.

An attachment point **60** is mechanically coupled to and follows power supply **50**, and can be any attachment device suitable for securing a leader string **70** so that the leader string can be pulled through a substantial run of conduit **10** by crawler **20**. Attachment point **60** can be any known mechanical, magnetic, or adhesive attachment, and it will be understood that leader string **70** can take any known form light enough and with sufficiently low friction to be pulled through conduit **10** by crawler **20**.

Referring next to FIG. **2**, crawler **20** is illustrated in its currently preferred form. Traction head **30** includes three equally-spaced coaxial tracks **32** biased apart into constant engagement with the inner wall of conduit **10** by spring-loaded struts **33** bearing against one another in balanced fashion at a central connection or support **133**, which could be a direct connection of the inner ends of the struts, or a connection of the struts to a distinct support structure. Tracks **32** are simultaneously driven to rotate at equal speed in a direction to pull traction head **30** through conduit **10** in the direction of the arrow. In the illustrated example, each track **32** includes a rubber-type endless caterpillar tread **32***a* riding around a row of wheels **32***b*, the wheels rotationally supported by shafts **32***c* on a carriage plate **32***d* that gives the track its structure. It will be understood that the force biasing tracks **32** against the inner wall of the conduit can be achieved in different ways, although the illustrated use of spring members is currently preferred.

The driving force for tracks **32** is supplied by a small DC electric motor **40** of known, commercially available type, coupled to a track drive mechanism **34** on traction head **30** by a rotating U-joint **39**. The motor drive shaft terminates in a rotating U-joint coupling **40***a* connected to a mating, rotating U-joint coupling **39***a* connected to a central worm drive shaft **35** journaled at its rearward end in fixed bearing sleeve **35***b* at the base of drive yoke **34***c*. Worm shaft **35** includes or supports a worm **34***a*, so that worm **34***a* is rotated by motor **40** acting through U-joint **39**. Worm **34***a* is in driving engagement with three worm gears **34***b* mounted to rotate on three equally spaced arms of yoke **34***c*. Each worm gear **34***b* has a hub supporting one end of a track link arm **37** and one end of a belt **38**. The other ends of each link arm **37** and belt **38** are connected to a corresponding one of tracks **32**, preferably via a grooved drive hub **36** extending off the rear (drive) wheel **32***b* of the track **32**. Link arms **37** maintain the spacing of tracks **32** from drive **34**, pivoting at connecting pins **37***a* and **37***b* when irregularities or curves are encountered in the conduit wall. Belts **38**, in the illustrated embodiment durable, high strength rubber bands, transfer the rotation of worm gears **34***b* to drive hubs **36** to rotate tracks **32**.

It might be desirable to bias motor **40** and traction head **30** toward each other as the crawler **20** travels through the conduit, particularly when going around curves. In the illustrated embodiment a coil tension spring **39***b* coaxially surrounds coupling **39** to apply a constant force tending to draw the motor and crawler head into coaxial alignment after a turn is negotiated, and further to ensure good transfer of power from the motor to the traction head. Similar springs could also be added to the electromechanical couplings **51** between the motor **40** and power supply elements **50**.

FIGS. **3** and **4** illustrate the details of the drive and support connections between tracks **32** and drive **34** from front and rear end views. In particular they illustrate the tractive connection between the tracks **32** and the inside wall of conduit **10**, and the radial spring forced exerted by struts **33** against their common axis to keep the tracks **32** in constant contact with the conduit wall.

FIGS. **6** and **7** show front and rear end views of a modified traction head **130**, identical in all respects to the structure illustrated in FIGS. **3** and **4**, except that two tracks **32** are used instead of three tracks.

Referring back to FIG. **2**, motor **40** pulls its own independent power supply **50** behind it, train-like, in the preferred form a linked series of batteries **50** connected both electrically and mechanically in series at **51** by suitably strong insulated electrical wire. It will be understood that while electrical wire alone is sufficient to keep the batteries **50** coupled to one another and to the motor **40**, it is possible to provide a separate mechanical connection between the batteries to relieve strain on the wiring. It will also be understood that while a train of multiple, serially-connected, relatively short-bodied batteries is illustrated as being the optimal arrangement for providing suitable DC voltage for motor **40** while negotiating the curves of the conduit, it would be possible to use a single battery to power motor **40** if the battery's voltage is high enough for the motor, and if the battery's length is short enough to negotiate the curves encountered in conduit **10**.

Crawler **20** preferably has a simple on/off control switch, schematically shown at **41** on a casing **40***b* around the motor **40** or directly on the motor housing (or anywhere else along the crawler "train"). Turning the switch to "on" supplies battery power to motor **40**, which in turn begins rotating treads **32** through linkage **39** and drive **34**. The rotational direction in this simple, preferred on/off embodiment is in a single direction, so that the crawler is placed in conduit **10** and released to drive itself through to the other end. It will be understood that it would also be possible to provide more sophisticated controls to motor **40**, for example to reverse the motor and/or to adjust its speed, for example using known remote controls of the type used in radio-controlled toys.

The crawler **20** is thus a fully and independently mobile machine, carrying its own power supply in the manner of a self-contained train without the need to trail power or control wiring behind it. It will be understood, however, that power or control wiring that remains connected to the crawler **20** would be possible, although not preferred, as it would add weight and increasing drag to the relatively small crawler as it traveled through the conduit.

FIG. **2** shows optional protective casings or shrouds **40***b* and **50***b* around motor **40** and at least one of batteries **50**. This could be, for example, a heat-shrunk flexible plastic material to seal the motor and batteries (and optionally the wiring between them) from dust and water that might be encountered in the conduit, or on the worksite outside the conduit.

FIG. **2** shows leader string attachment point **60** as a simple eye-hook, attached directly to the last battery **50** in the crawler train. As noted above, the form of attachment point **60** can vary, and the manner of its connection to the end of the crawler train can likewise vary, including but not limited to direct and indirect attachments to the batteries or to any casings such as **40***b* around the batteries. It would also be possible to connect attachment point **60** to a more forward part of crawler **20**, although the end-mounting is preferred to prevent interference between the leader string and the crawler.

FIG. **2** does not show an optional gear reduction transmission between the motor **40** and the traction head **30**, but those skilled in the art will readily be able to find commercially and/or build such gear reduction transmissions if the drive ratio of motor **40** would benefit for a particular use.

It will finally be understood that the disclosed embodiments are representative of presently preferred forms of the invention, but are intended to be explanatory rather than limiting of the invention. Reasonable variation and modification of the invention as disclosed in the foregoing disclosure and drawings are possible without departing from the scope of the invention. The scope of the invention is defined by the following claims.

What is claimed is:

1. A device for pulling a leader string through a wire or cable conduit, comprising:

a powered tractor device sized to fit inside a conduit, the tractor device comprising a traction head comprising two or more opposed drive tracks spaced apart with a bias adapted to force them outwardly into contact with opposed sides of an inner wall of a conduit when the tractor device is in a conduit, a motor connected to operate the drive tracks to pull the tractor device through a conduit, and a power supply connected to operate the motor, the entirety of the tractor device capable of traveling through a conduit, the tractor device further comprising an attachment point for attaching a leader string to the tractor device such that the tractor device is capable of pulling the leader string through a conduit.

2. The device according to claim **1**, wherein the motor and power supply are flexibly coupled with a flexible coupling to the traction head to be pulled behind the traction head.

3. The device according to claim **2**, wherein the power supply comprises a battery.

4. The device according to claim **2**, wherein the motor and the power supply are separate and are connected serially behind the traction head with flexible couplings.

5. The device according to claim **4**, wherein one or more of the flexible couplings comprises a tension spring biasing portions of the tractor device coupled by the spring into coaxial alignment.

6. The device of claim **1**, wherein the traction head comprises three opposed drive tracks equally spaced about a central axis.

7. The device of claim **4**, wherein the motor is connected to the traction head with a flexible drive coupling.

8. The device of claim **7**, wherein the motor is connected to the traction head through a separate drive mechanism connected with flexible drive couplings between the traction head and the motor.

9. The device of claim **7**, wherein the flexible drive coupling further comprises a spring surrounding a rotating drive element, the spring tending to draw the traction head and the motor together.

10. The device of claim **1**, wherein the drive tracks are spaced apart with a spring bias.

11. The device of claim **1**, wherein the drive tracks are spaced apart with a bias adapted to force them outwardly into essentially constant contact with opposed sides of an inner wall of a conduit when the tractor device is in a conduit.

* * * * *